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PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO CONTACT ELEMENTS

(71) We, RINGSDORFF-WERKE GMBH, a German company of Königswinterer Strasse 1,D-5300 Bonn-Bad Godesberg 10, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a contact element, more particularly, but not exclusively a brush, which contains graphite particles and metal.

Contact elements, and in particular brushes for electric machines and contact shoes for electric railways or trolley 'buses, which are made from carbon or graphite, can generally only be used for low and medium currents because of the damage to which they are likely to be subjected by possible overloading of the contact element. For high electric loads, it is necessary to use contact elements whose major component, by weight, is copper, a copper alloy, silver or another suitable metal, and in which graphite is only present in an amount smaller than otherwise. In contrast to contact elements made of graphite, brushes and contact elements such as contact shoes which contain metal undergo wear to a considerably higher degree. The amount of wear which they undergo is approximately proportional to the metal content of the contact element. The high rate of wear of the contact elements is usually due to the complete lack of wear-retarding lubricating films, and roughening of the sliding surfaces by sparks, and necessitates the frequent renewal of the contact elements and involves increased consumption of material.

According to the present invention, there is provided a contact element, which comprises a structure formed of graphite particles encased in metallic shells connected one to another to form a lattice structure, the metallic shells comprising more than 50% by weight of metallic copper.

It is because it possesses a low specific electrical resistivity that copper contitute the main component of the shell-like casings for the graphite particles. Since metallic copper will always be the main component, by weight, of the shell-like casings and may be the sole material from which the casings are made, irrespective of any additional materials which may be employed together with copper in the production of the casings as will be described hereinafter, the casings are herein termed "metallic".

In a preferred form of contact element embodying this invention, the shell-like casings contain one or more of the elements Al, Si, Mn, Fe, Zn, Mo, Ag, Cd, Sn and Pb in elemental form, in addition to the copper, to improve the sintering activity and hence the strength of the contact element. The shell-like casings around the graphite particles can even contain the oxide or sulphide of copper or any of these additives. Oxides or sulphides of the additives can be used as an alternative or in addition to using the additives in elemental form. Some of these additives, particularly additions of cadmium or lead have a spark-extinguishing action, or modify the sliding and polishing properties of the contact element. The shell-forming material, including additional elements, oxides or sulphides, if present, preferably amounts to from 10 to 60% by weight of the contact element. The additive elements, oxides or sulphides will preferably constitute, *in toto*, not more than 1% by weight of the contact element. With another preferred form of contact element embodying this invention, carbon and/or graphite in powder form, such as carbon black or wood charcoal and/or natural graphite or electrographite, this carbon not being coated by metal, and/or inorganic lubricant and polishing substances, for example molybdenum disulphide, cadmium sulphide and vitreous substances, for example glass powder, as well as possibly metal powder, are arranged in the contact element between the metal-encased graphite particles. These additives are of particular advantage when the contact ele-

ments are to be used in dry or corrosive atmospheres which inhibit the formation of sliding or lubricating films.

To produce contact elements embodying this invention, fractions of natural graphite or electrographite particles screened or sifted, preferably to a particle size range of from 10 to 150 μm are coated with metal shells for example, by electroplating or electroless metallisation or by vapour-coating in a fluidised bed. The coating will preferably have a thickness of from one tenth to one twentieth of the graphite particle size. The coated particles are mixed with any additional materials, including additional elements, oxides, sulphides, lubricating and friction-reducing substances and/or a binder for example a curable synthetic resin, which is/are to be used, before being compressed on die presses or even isostatically into shaped bodies, which are thereafter subjected in an inert or reducing atmosphere to a thermal treatment whereby the metallic shells of the graphite particles which are contacting one another are at least partially sintered and any additional materials as aforesaid become incorporated in the metallic shells around the graphite particles.

It has been found that the electrical resistivity of metal-containing contact elements is considerably reduced by the arrangement of the metal components as provided according to the invention. A coherent, three-dimensional, metallic lattice structure is formed in the production of contact elements according to the invention irrespective of the thickness of the shells enclosing the graphite particles. With the prior art metal-containing contact elements referred to above, the establishment of a coherent lattice is only possible when the contact elements possess a very high metal content. When the contact elements have a smaller metal content, the metal grains are largely embedded in the form of isolated grains in a graphite matrix.

The electrical resistivity of a volume element which is approximately the sum of the proportional resistivities of the components thereof is considerably greater than the resistivity of a contact element containing the components with high electrical conductivity in the form of a continuous lattice. Hence, in the former case, the metal content has to be increased to the point of the development of a continuous metal grid, so as to avoid overloading. However, in such a case, the contact properties and the speed of wear of the element are impaired. In contrast, with a contact element according to this invention, the specific electrical resistivity thereof, even when the contact element has a small metal content, is comparatively low, and the contact, e.g. a brush, can be given a high electric load. Contact elements according to the invention possess better contact and sliding properties and above all a considerably reduced rate of wear with respect to the aforementioned prior art types of contact elements.

The following Example illustrates the invention.

EXAMPLE.

(a) Natural graphite powder particles with a grain size in the range of from 10 to 150 μm were copper-plated by electroplating, the amount of deposited copper being 30% by weight. The copper coated particles were then compressed at a pressure of about 3 Megaponds/cm^2 to form brushes.

(b) In a comparative test, the same graphite powder was mixed with 55% by weight of copper powder and the mixture was likewise compressed to form brushes.

The brushes were thereafter sintered in each case in a hydrogen atmosphere at a temperature of 600°C, the sintering time being 4 hours. The rate of wear of both types of brushes was then measured under the same conditions on an automobile fan motor.

TABLE

	Brush produced according to (a)	Brush produced according to (b)
Specific electrical resistivity ($\mu\Omega$cm)	45	45
Brush wear (mm/100 hours)	0.1	0.25
Collector wear (mm/100 hours)	0.01	0.05

WHAT WE CLAIM IS:—

1. A contact element which comprises a structure formed from graphite particles encased in metallic shells connected to one another to form a lattice structure, the metallic shells comprising more than 50% by weight of metallic copper.

2. A contact element as claimed in claim 1, wherein the metallic shells consist solely of copper.

3. A contact element as claimed in claim 1, wherein the metallic shells additionally contain one or more of the elements aluminium, silicon, manganese, iron, zinc, molybdenum, silver, cadmium, tin and lead, in elemental form.

4. A contact element as claimed in claim 1 or 3, wherein the metallic shells additionally contain one or more of the elements copper, aluminium, silicon, manganese, iron, zinc, molybdenum, silver, cadmium, tin and lead in oxide or sulphide form.

5. A contact element as claimed in claim 3 or 4, in which said one or more elements and/or the oxide(s) or the sulphide(s) constitute up to 1% by weight of the contact element.

6. A contact element as claimed in any one of the preceding claims, in which the shell-forming material constitutes from 10 to 60% by weight thereof.

7. A contact element as claimed in any one of the preceding claims, which additionally comprises uncoated carbon and/or graphite powder.

8. A contact element as claimed in claim 7, in which the carbon and/or graphite powder is selected from carbon black, wood charcoal, natural graphite and electrographite.

9. A contact element as claimed in any one of the preceding claims, which additionally contains a lubricant and/or a polishing substance.

10. A contact element as claimed in Claim 9, which contains molybdenum disulphide, cadmium sulphide, a vitreous substance or a metal powder.

11. A contact element as claimed in any one of the preceding claims, in which the graphite encased in shells has a particle size of from 10 to 150 μm.

12. A contact element as claimed in any one of the preceding claims, which is a brush.

13. A contact element as claimed in Claim 1, substantially as described in the foregoing Example.

14. A method for the production of a contact element as claimed in Claim 1, which comprises providing graphite particles with a metal coating comprising copper, compressing the particles thus coated and heating them in an inert or reducing atmosphere to at least partially sinter together the metal coating of the graphite particles, the quantity of copper in said coating being such that the metal shells thus produced around the graphite particles contain more than 50% by weight of copper.

15. A method as claimed in Claim 14, in which the graphite particles are electroplated with metal.

16. A method as claimed in Claim 14, in which the graphite particles are coated with metal by electroless metallisation.

17. A method as claimed in Claim 14, in which the graphite particles are coated with metal by vapour coating in a fluidised bed.

18. A method as claimed in any one of Claims 14 to 17, in which the graphite particles are coated with metal to a thickness of from one tenth to one twentieth of the graphite particle size.

19. A method as claimed in any one of the Claims 14 to 18, in which the graphite particles have been screened to a particle size of from 10 to 150 μm.

20. A method as claimed in any one of Claims 14 to 19, in which the metal coated graphite particles are mixed with a binder before being compressed.

21. A method as claimed in Claim 20, in which the binder is a curable synthetic resin.

22. A method for the production of a contact element as claimed in Claim 14, substantially as described in the foregoing Example.

23. A contact element, whenever produced by the method claimed in any one of Claims 14 to 22.

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